THE

KANSAS UNIVERSITY SCIENCE BULLETIN.

Vol. I, No. 7—September 1902.

(Whole Series, Vol. XI, No. 7.)

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COAL MEASURES FAUNAL STUDIES, II (Beede and Rogers)—FAUNA OF THE SHAWNEE FORMATION (Haworth), THE WABAUNSEE FORMATION (Prosser), and THE COTTONWOOD LIMESTONE, ... *J. W. Beede.*

PUBLISHED BY THE UNIVERSITY,

LAWRENCE, KAN.

Price of this number, 25 cents.

Entered at the post-office in Lawrence as second-class matter.

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VOL. I, No. 7. SEPTEMBER, 1902. WHOLE SERIES, VOL. XI, No. 7.

COAL MEASURES FAUNAL STUDIES, II.

(BY J. W. BEEDE AND AUSTIN F. ROGERS.)

FAUNA OF THE SHAWNEE FORMATION (HAWORTH), THE WABAUNSEE FORMATION (PROSSER), THE COTTONWOOD LIMESTONE.

BY J. W. BEEDE.

BEING a continuation of the foregoing lists of Rogers, published in this journal, vol. IX, No. 4, pp. 232–254.[1]

The present paper deals with the fauna of the rocks, beginning at the base of what Haworth has called the "Shawnee formation"[2] and continuing upward to the top of the Cottonwood limestone. The strata are treated in ascending order. It must be borne in mind that it is the object of these papers to bring out the fauna of the rocks of the Kansas Coal Measures in sufficient detail to establish time divisions on a paleontological basis. These lists are, of course, incomplete for the horizons *in toto*, but it is hoped that they do give the characteristic fossils of the rocks of the Kansas river section in sufficient fulness to warrant some deductions of value. The fauna of the Lower Coal Measures still remains to be completed.

20. KANWAKA SHALES (Adams MSS., by permission U. S. Geological Survey). Bennett's description:[3] "Above the last (Oread) limestone lies a heavy shale deposit, at least ninety-seven feet thick at Lecompton. The lower sixty-five feet of this is a clay shale, then sixteen feet of arenaceous shale, then five feet

1. In justice to Mr. Rogers, it should be stated that he did not see the proof of the first article and is not to blame for the very bad errors which it contains.

2. Univ. Geol. Surv. Kans., III, pp. 93, 94, 1898.

3. Univ. Geol. Surv. Kans., I, p. 116, 1896.

of sand rock, above which lies eleven feet of sandy buff shales." No fossils known from this horizon.

21. LECOMPTON LIMESTONE. Bennett's description: "Capping the hills around Lecompton is a five-foot limestone in two layers, which we will provisionally name the 'Fusulina' limestone; not that it alone bears that fossil, but because of the abundance of *Fusulina* in it. It is the lower of another triple system [formation] of limestones, the members of which are separated by a few feet of shale, and which retain this order as far as observed to the west. Above the 'Fusulina' stratum are five and one-half feet of clay shales, then one and one-fourth feet of blue limestone, which weathers dark buff, like all its associate strata. Above this are four feet of shales having a bituminous streak in the middle; then ten feet of light gray, easily disintegrated limestone. This group [formation] may be called the Lecompton limestone, on account of their outcropping being near Lecompton. At Spencer, six miles west of Lecompton, the upper part of the series [formation] finally disappears below the alluvial soils of the valley."

From near the horizon of the above formation, from a well in the road in the bed of Deer creek (the one emptying into Wakarusa creek), near the Shawnee-Douglas county line, the following species have been collected:

Fusulina secalica (Say).

Campophyllum torquium Owen.

Archæocidaris cf. *agassizi* Hall.

Fenestella limbata Foerste.

Fenestella limbata remota Foerste.

Pinnatopora sp.

Polypora distincta Ulrich?

Polypora elliptica Rogers? It is quite probable that this is a distinct species. It has fenestrules arranged in two intersecting series when viewed on the reverse side, and the branches are not striated. The fenestrules appear nearly square on account of their arrangement, but in reality they are subcircular. On the obverse side the nodes are very prominent and some of them appear to possess acanthopores.

Polypora cf. *nodocarinata* Ulrich.

Rhombopora lepidodendroides Meek.

Chonotes granulifer Owen.

Productus nebraskensis Owen.
Productus pertenuis Meek.
Reticularia perplexa (McChesney) Schuchert.
Seminula argentia (Shepard) Hall.
Spirifer cameratus Morton.
Aviculopecten carboniferus (Stevens) Meek.
Aviculopecten maccoyi Meek and Hayden.
Aviculopecten occidentalis (Shumard) White.
Limopteria gibbosa (Meek and Worthen).

22. TECUMSEH SHALES. A stratum of shales about seventy-five feet in thickness, nearly non-fossiliferous, of fine texture, containing abundant ferruginous concretions and occasional layers of soft shaly sandstone. According to Bennett, these may represent the Kanwaka shales.[4]

23. DEER CREEK LIMESTONE.[4] Three layers of limestone separated by layers of shale. The total thickness of the formation is fifteen to twenty-five feet. The principal stratum is the uppermost, which is from seven to twelve feet thick. Most of the fossils below are collected from this upper layer. It is a massive, light gray limestone, tinged with yellow. The texture often varies much in a short distance, grading into inclusions or banks of blue argillaceous limestone in which the fossils are excellently preserved. It is best exposed at Calhoun's Bluffs, in the cut of the Union Pacific railroad three miles northeast of Topeka.

Fusulina secalica (Say).
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
Archæocidaris agassizi Hall.
Oligoporus minutus Beede.
Crinoid stems.
Fenestella hexagonalis Rogers?
Fenestella sp.
Pinnatopora pyriformis Rogers.
Polypora distincta Ulrich? Probably a new species. It differs from this species in having fenestrules broader and shorter and slightly more slender branches. However, this may be due in a large part to the particular portion of the zoarium of which our specimens are fragments.

4. "Deer Creek Limestone," Univ. Geol. Surv. Kans., II, p. 117.

Polypora nodocarinata Ulrich.
Septopora pinnata Ulrich.
Ambocœlia planoconvexa (Shumard) Hall and Clarke.
Chonetes granulifer Owen.
Crania modesta White?
Derbya crassa (Meek and Hayden) Waagen.
Derbya keokuk (Hall and Clarke).
Dielasma bovidens (Morton) White.
Enteletes hemiplicata (Hall) Hall and Clarke.
Meekella striaticostata (Cox) White and St. John.
Productus cora d'Orbigny.
Productus costatus Sowerby? de Koninck.
Productus longispinus Sowerby.
Productus nebraskensis Owen.
Productus pertenuis Meek.
Productus punctatus (Martin) Morton.
Productus semireticulatus (Martin) d'Orbigny.
Pugnax utah (Marcou) Hall and Clarke.
Reticularia perplexa (McChesney) Schuchert.
Seminula argintia (Shepard) Hall and Clarke.
Spirifer cameratus Morton.
Spiriferina cristata (Schlotheim) Dawson.
Allorisma granosum (Shumard) Keyes.
Allorisma subcuneatum Meek and Hayden.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
Aviculopecten sp.
Entolium aviculatum (Swallow) Meek.
Myalina kansasensis Shumard?
Myalina swallowi McChesney.
Pinna peracuta Shumard.
Pinna subspatulata Worthen?
Bellerophon crassus Meek and Worthen.
Trachydomia wheeleri (Swallow) Keyes.
Pleurotomaria tabulata Hall.
Conularia crustula White? (Very large for this species.)

24. Calhoun Shales. This formation is fifty to sixty-five feet in thickness. The lower part is a layer of soft argillaceous sandstone from twelve to twenty feet thick. The upper portion of the formation is a bluish shale, arenaceous below, clayey above, and of comparatively fine texture. No fossils have been

collected from this formation, except a few fragments of *Calamites* and *Cordaites* in a soft sandstone immediately beneath the Topeka limestone, in the eastern part of that city. The type exposure is at Calhoun's Bluffs, three miles northeast of Topeka.

25. HARTFORD (TOPEKA) LIMESTONE. (Adams's MSS., by permission of U. S. Geological Survey.) The following section of the rocks is about as given by Doctor Bennett when he first described them:

		ft.	in.
g.	Limestone weathering buff	2	0
f.	Drab shales	3	0
e.	Limestone weathering buff	1	6
d.	Buff calcareous shales with abundant fossils	2	0
c.	Blue to brown limestone, always weathering to a brown buff, cherty near the top, fossiliferous	5	8
b.	Blue shales	1	6
a.	Blue limestone, weathering dark buff	6	0
	Total thickness of formation	21	8

Most of the fossils enumerated below were taken from layers *c* and *d*, though the entire set is more or less fossiliferous, with about the same species running through them.

Fusulina secalica (Say).

Amblysiphonella prosseri Clarke.

Lophophyllum profundum (Milne-Edwards and Haime) Foerste.

Crinoid stems and plates, referred by Bennett to *Zeacrinus mucrospinus* and *Z. acanthophorus*.

Archæocidaris agassizi Hall.

Archæocidaris trudifer White.

Worm.

Fenestella shumardi Prout.

Fenestella remota Foerste.

Polypora elliptica Rogers.

Polypora submarginata Meek.

Rhombopora lepidodendroides Meek.

Septopora biserialis (Swallow) Foerste.

Septopora sp.

Ambocœlia planoconvexa (Shumard) Hall and Clarke.

Chonetes granulifer Owen.

Derbya crassa (Meek and Hayden) Waagen.

Derbya keokuk (Hall) Hall and Clarke.

Dielasma bovidens (Morton) White.

Hustedia mormoni (Marcou) Hall and Clarke.
Meekella striaticostata (Cox) White and St. John.
Orbiculoidea missouriensis (Shumard) Hall and Clarke.
Productus cora d'Orbigny.
Productus costatus Sowerby? de Koninck.
Productus longispinus Sowerby?
Productus nebraskensis Owen.
Productus pertenuis Meek.
Productus punctatus (Martin) Morton.
Productus semireticulatus (Martin) d'Orbigny.
Reticularia perplexa (McChesney) Schuchert.
Seminula argentia (Shepard) Hall and Clarke.
Spirifer cameratus Morton.
Spiriferina cristata (Schlotheim) Dawson.
Allorisma granosum (Shumard) Keyes.
Allorisma subcuneatum Meek and Hayden.
Astartella vera Hall.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
Entolium aviculatum (Swallow) Meek.
Limopteria marian (White) Beede?
Macrodon Cf. *tenuistriatus* Meek and Worthen.
Macrodon sp.
Myalina swallowi McChesney.
Pinna peracuta Shumard.
Schizodus curtus Meek and Worthen.
Schizodus curtiformis Wolcott.
Schizodus rossicus de Verneuil.
Aclisina swalloviana (Geinitz) Meek, and other gastropods too poorly preserved to be identified.
Bellerophon carbonarius Cox.
Orthoceras sp.
Griffithides scitula (Meek and Worthen) Vogdes.

26. Severy Shales. These shales are blue below, varying through yellow to black in places above the coal. They are fifty to seventy-five feet in thickness. The texture varies, and in the upper part they contain the Osage coal, which is mined at Topeka, Burlingame, Osage City, and other places.

In correlating isolated sections the rocks between the Topeka limestone and the Barclay (= Burlingame = Wyckoff, etc.) limestone have been somewhat confused. Under the title, "Stratig-

raphy of the Kansas Coal Measures,"[5] Haworth describes them as follows: "Above them (Topeka limestones) lies another shale bed fifty feet thick, at the top of which lies the Topeka coal, a seam about eleven inches thick, which has been mined in different places. The coal is immediately overlaid by two thin limestone beds, separated by less than three feet of shales. Above the limestone is the Osage City shale, more than 100 feet thick, at the top of which is the Osage coal, averaging eighteen or twenty inches thick. . . . Above the Osage coal is a thin limestone system [formation], superseded in turn by the Burlingame shales, a body about 150 feet thick in the vicinity of Burlingame, and possibly more in places. Both the Burlingame and Osage City shales extend for long distances to the southwest and northeast, and are important landmarks in stratigraphy." Bennett[6] describes the succession at Topeka correctly, but supposes the coal above the Topeka coal corresponds to the Osage horizon, instead of to the one already indicated in this paper as its equivalent.

Haworth's statement in Vol. I, p. 162, of the Kansas Survey, is practically a repetition of the one just quoted, but he corrects the correlation of the coals in a foot-note at the bottom of page 161. In volume III of the same reports (p. 94) he uses the term "Osage shales" for all the shales between the Topeka limestone and the Barclay limestone. The section is correctly given by Hall in his "Section from Boicourt to Alma,"[7] though it is not clear just what is meant by his "Osage City Shales, Coal, and Limestone."

From the foregoing, it will be seen that the terms "Osage City" and "Burlingame," when strictly applied, are proposed for one and the same set of rocks, namely, those above the Osage-Topeka coal, while the shales below the coal and above the Hartford limestone are not designated at all. Later, in Vol. III of the University Survey (p. 66), in quoting Doctor Adams's notes, Professor Haworth gives the following: "*Severy Shales.*—'Above the Elk Falls limestone is a bed of shales averaging fifty to seventy-five feet in thickness, which, with the protected limestones above, forms a light escarpment that may be

5. Kans. Univ. Quart., III, p. 278, 1895.

6. Univ. Geol. Surv. Kans., I, pp. 118, 119, 1896.

Ibid., p. 394.

traced from a few miles below Eureka to Cedar valley, forming a line from two to five miles west of the Elk Falls escarpment. This shale bed is therefore sufficiently prominent to be recognized in the field, and to be of considerable local and stratigraphic importance. The town of Severy lies within it, and therefore it may be called the Severy shales.''' Dr. George I. Adams, of the United States Geological Survey, under whose direction the work of correlating the Coal Measures rocks of Kansas was done last summer, informs me that the names used in this paper and accredited to him have been passed upon by the committee on nomenclature, and he has kindly permitted me to use them in advance.

So far as known these shales are not fossiliferous, save for a few fragments of fern leaves, below the coal, but are very fossiliferous locally just above it.

Lophophyllum profundum (Milne-Edwards and Haime) Foerste.

Ceriocrinus craigi (Worthen) Wachsmuth and Springer.

Ceriocrinus harshbargeri Beede.

Ceriocrinus hemisphericus (Shumard) Wachsmuth and Springer. These three species of crinoids are from the dump, and may be from the shales between the two layers of the Howard limestone above.

Spirorbis sp.

Fenestella dentata Rogers.

Fenestella limbata Foerste.

Fenestella mimica Ulrich.

Pinnatopora elliptica Rogers.

Polypora whitei Foerste.

Ambocœlia planoconvexa (Shumard) Hall and Clarke.

Chonetes glaber Geinitz.

Chonetes granulifer Owen.

Derbya crassa (Meek and Hayden) Waagen.

Dielasma bovidens (Morton) White.

Hustedia mormoni (Marcou) Hall and Clarke.

Lingula umbonata Cox. If this species is considered separate from *L. mytiloides*, the specimens here referred to would probably be classed with the latter.

Productus cora d'Orbigny.

Productus longispinus Sowerby.

Productus nebraskensis Owen.

Productus pertenuis Meek.
Productus semireticulatus (Martin) d'Orbigny.
Productus symmetricus McChesney.
Pugnax utah (Marcou) Hall and Clarke.
Reticularia perplexa (McChesney) Schuchert.
Seminula argentia (Shepard) Hall and Clarke.
Spirifer cameratus Morton.
Spiriferina cristata (Schlotheim) Dawson.
Astartella vera Hall.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
? *Aviculopecten whitei* Meek?
Cardiomorpha missouriensis Shumard?
Edmondia sp.
? *Myalina exasperata* Beede.
Myalina perattenuata Meek and Hayden.
Myalina swallowi McChesney.
Nucula ventricosa Hall.
Pleurophorus tropidopherus Meek.
Schizodus curtus Meek and Worthen.
Schizodus sp.
Solenomya radiata Meek and Worthen.
Sedgwickia topekensis (Shumard) Meek and Hayden.
Bellerophon Cf. *bellus* Keyes.
Euomphalus subrugosus (Meek and Worthen) Meek.
Pleurotomaria perhumerosa Meek.
Pleurotomaria sphærulata Conrad.
Pleurotomaria subdecussata Geinitz.
Orthoceras cribosum Geinitz.
Griffithides scitula (Meek and Worthen) Vogdes.

27. Howard Limestone. This consists of two thin layers of limestone separated by two to ten feet of shales. The lower of these is a hard, blue limestone from twenty inches to two feet in thickness, quite fossiliferous in places, and sometimes quite full of crinoid stems and of fish teeth. The upper layer is usually coarser and more shaly. The clay between them is often very fossiliferous.

From Doctor Adams's notes, published by Professor Haworth,[8] it will be seen that the Howard limestone is the same as the

8. Ibid., pp. 66, 67.

rock over the Osage coal, and that his Severy shale is the same as the Osage City shales.

Some of the fossils here listed were collected from ballast near Lawrence, on the old Carbondale railroad, which was taken from this layer of rock at Carbondale. These references are marked with an asterisk.

* *Fusulina secalica* (Say).
* *Campophyllum torquium* Owen.
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
* *Lophophyllum westii* Beede.
Ceriocrinus monticulatus Beede.
Erisocrinus megalobrachius Beede.
Scaphiocrinus washburni Beede.
Spirorbis sp.
* *Chainodictyon laxum* Foerste.
Fenestella dentata Rogers.
Fenestella remota Foerste.
* *Fenestella shumardi* Prout.
Fistulipora nodulifera Meek.
Pinnatopora pyriformipora Rogers ?
Pinnatopora tenuilineata (Meek) Ulrich.
Polypora aspera Rogers.
Polypora elliptica Rogers.
* *Polypora* sp.
Rhombopora lepidodendroides Meek.
Streblotrypa prisca Gabb and Horn.
Ambocœlia planoconvexa (Shumard) Hall and Clarke.
Chonetes glaber Geinitz.
Chonetes granulifer Owen.
Derbya crassa (Meek and Hayden) Waagen.
Derbya keokuk (Hall) Hall and Clarke.
Dielasma bovidens (Morton) White.
Enteletes hemiplicata (Hall) Hall and Clarke.
Productus cora d'Orbigny.
Productus costatus Sowerby ? de Koninck.
Productus longispinus Sowerby.
Productus nebraskensis Owen.
Productus pertenuis Meek.
Productus punctatus (Martin) Morton.
Productus semireticulatus (Martin) d'Orbigny.

Pugnax utah (Marcou) Hall and Clarke.
Seminula argentia (Shepard) Hall and Clarke.
Spirifer cameratus Morton.
Spiriferina cristata (Schlotheim) Dawson.
Allorisma costatum Meek and Worthen.
Allorisma geinitzi Meek.
Allorisma granosum (Shumard) Keyes.
Allorisma kansasensis Beede.
Aviculopecten carboniferus (Stevens) Meek.
Aviculopecten hertzeri Meek.
Aviculopecten maccoyi Meek and Hayden.
Aviculopinna americana Meek.
Edmondia aspenwallensis Meek.
Edmondia nebraskensis (Geinitz) Meek.
Entolium aviculatum (Swallow) Meek.
Lima retifera Shumard.
Limopteria gibbosa (Meek and Worthen).
Macrodon cf. *tenuistriata* (Geinitz) Meek and Worthen.
Modiola subelliptica Meek.
Myalina kansasensis Shumard.
Myalina swallowi McChesney.
Nucula? sp. (cast, very small).
Nuculana bellistriata attenuata Meek var.
Pinna lata Beede.
Placunopsis carbonaria Meek and Worthen.
? Pseudomonotis hawni equistriata Beede var.?
* *Pteria longa* (Geinitz).
Schizodus alpina (Hall) Keyes.
Schizodus circulus Worthen.
Schizodus wheeleri (Swallow) Meek.
Yoldia subscitula Meek and Hayden.
Bellerophon carbonaria Cox.
Bellerophon crassus Meek and Worthen.
Bellerophon montfortianus Norwood and Pratten.
* *Bellerophon percarinatus* Conrad.
Bulimorpha nitidula (Meek and Worthen) Keyes.
Capulus parvus Swallow.
Pleurotomaria illinoiensis Worthen? Differs from this species in being much smaller and in having a larger number of nodes

to the whorl. The notch in the lip extends back some distance as a thin, almost linear slit.

Pleurotomaria tabulata Conrad.

Soleniscus sp.

Sphærodoma medialis (Meek and Worthen) Keyes.

Sphærodoma ponderosa (Swallow) Keyes?

Sphærodoma sp.

Strophostylus nana (Meek and Worthen) Keyes.

? *Glyphæoceras* sp. (Two specimens, very small and not so preserved as to be well identified.)

* *Goniatites subcavus* Miller and Gurley.

* *Metacoceras sangamonensis* (Meek and Worthen) Hyatt.

* *Nautilus planovolvis* Shumard.

Orthoceras Cf. *rushensis* McChesney. Pittings on part of the surface.

Solenocheilus Cf. *collectus* Hyatt.

Stearoceras gibbosum Hyatt? Perhaps a young specimen of this species, though it will probably prove to be different. The cast preserves a fine line down the center of the ventral surface which disappears before reaching the deep sinus. The sinus is somewhat shallower than that figured by Hyatt, and it may be an *Endolobus*.

Griffithides scitula (Meek and Worthen) Vogdes.

28. Burlingame Shales. Olive shales, generally very argillaceous, though arenaceous in streaks, and in places even contain sandstone. These shales are 120 feet or more in thickness, and for the most part are not fossiliferous, though in places fossils are very abundant. In the upper part is the Dover-Silver Lake coal, and above it usually a layer of impure limestone.

Chonetes granulifer Owen.

Hustedia mormoni (Marcou) Hall and Clarke.

Lingula umbonata Cox. (See previous note to this species.)

Orbiculoidea missouriensis (Shumard) Hall and Clarke.

Productus nebraskensis Owen.

Seminula argentia (Shepard) Hall.

Aviculopecten occidentalis (Shumard) Meek and Hayden.

Aviculopecten whitei Meek?

Myalina congeneris Walcott?

Myalina perattenuata Meek and Hayden.

Myalina swallowi McChesney.
Nucula? sp.
Nuculana bellistriata attenuata Meek var.
Pinna peracuta Shumard.
Pleurophorus Cf. *angulatus* Meek and Worthen.
Pleurophorus tropidopherus Meek.
Pseudomonotis hawni Meek.
Sedgwickia topekensis (Shumard) Meek and Hayden.
Bellerophon carbonarius Cox.
Bellerophon marcouianus Geinitz.
Dentalium meekianum Geinitz.
Euomphalus subrugosus (Meek and Worthen) Meek.
Gastropod, minute, undetermined.
Pleurotomaria subdecussata Geinitz.
Ostracoda.

29. Barclay Limestone. (Adams, MSS., by permission of U. S. Geological Survey.) Base of the Wabaunsee formation. For the present it seems best to group several strata in this formation.[9] They cannot well be mapped on the scale of the U. S. folios, and they are also intimately connected faunally, and usually all assist in producing a high escarpment with the upper part retreating. The rocks aggregate about seventy feet in thickness. The following section will serve to give an idea of these rocks:

		ft.	in.
g.	Gray, argillaceous, fossiliferous limestone, from 1 foot to	2	0
f.	Bluish calcareous shales with *Enteletes*, *Myalina*, *Allorisma* and *Bellerophon* fauna, from 8 feet to	20	0
e.	Hard, shelly, bluish limestone	4	0
d.	Shales with thin limestones, varying from 21 feet to	40	0
c.	Hard gray limestone weathering light yellow, from 1½ feet to	1	0
b.	Thin layer of shale	0	6
a.	Massive yellowish-gray limestone, very hard, with but few fossils, from 4 to 7 feet thick, averaging about	6	0

Most all of the fossils listed below are from layers *e*, *f*, and *g*, by far the greater part ranging through all three.

Somphospongia multiformis Beede (from Robinson, Brown county).

Aulacorhynchus millepunctatus (Meek and Worthen) Hall and Clarke?

Derbya crassa (Meek and Hayden) Waagen.

9. For a more detailed description of these rocks, see Trans. Kans. Acad. Sci., XV, p. 30.

Dielasma bovidens (Morton) White.
Enteletes hemiplicata (Hall) Hall and Clarke.
Meekella striaticostata (Cox) White and St. John.
Productus cora d'Orbigny.
Productus punctatus (Martin) Morton.
Seminula argentia (Shepard) Hall.
Allorisma costatum Meek and Worthen.
Allorisma geinitzi Meek.
Allorisma granosum (Shumard) Meek.
Allorisma subcuneatum Meek and Hayden.
Allorisma sp.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
Edmondia aspenwallensis Meek.
Edmondia ovata Meek and Worthen.
Edmondia cf. *nebraskensis* Meek.
Macrodon sp.
Myalina perattenuata Meek and Hayden.
Myalina subquadrata Shumard.
Pinna peracuta Shumard.
Pleurophorus sp.
Pseudomonotis kansasensis Beede.
Pseudomonotis hawni Meek and Hayden.
Pseudomonotis cf. *robusta* Beede.
? Sedgwickia altirostrata Meek and Hayden.
Bellerophon carbonarius Cox.
Bellerophon marcouianus Geinitz.
Bellerophon cf. *montfortianus* Norwood and Pratten.
Bellerophon percarinatus Conrad.
Bulimorpha nitidula (Meek and Worthen) Keyes.
Capulus sp.
Soleniscus paludinæformis (Hall) White.
Sphærodoma texana (Shumard) Keyes.
Orthoceras sp.
Tainoceras occidentalis (Swallow) Hyatt?

30. Willard Shales. These shales are fifty-five feet thick in their thinnest exposure, and are thicker in some places. Bennett gives their thickness at Willard at from seventy-five to eighty-five feet, including a thin stratum of limestone.[10] The

10. Univ. Geol. Surv. Kans., I, pp. 119, 120, 1896.

Bennett collection contains the following specimens taken from this thin limestone:

Fusulina secalica (Say) Fischer.
Meekella striaticostata (Cox) White and St. John.
Productus semireticulatus (Martin) d'Orbigny.
Bellerophon sp.

31. Chocolate Limestone. This name, as well as the one preceding and the one following, are used merely for convenience here, as they have been used before for the designation of these rocks, knowing that with further study and careful tracing they will be found to be the equivalents of similar rocks on the Neosho river section. This limestone is buff brown in color, varying from seven to ten feet in thickness, composed principally of two layers of massive stone, the upper of which is composed largely of the large variety of *Fusulina secalica*. In the Kansas river region it always forms high escarpments with rocky edges. It is not rich in any fossils except the *Fusulinas*.

Fusulina secalica (Say).
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
Chonetes granulifer Owen.
Enteletes hemiplicata (Hall) Hall and Clarke.
Meekella striaticostata (Cox) White and St. John.
Productus cora d'Orbigny.
Productus nebraskensis Owen.
Seminula argentia (Shepard) Hall.

32. Shales and sandstones shown near Dover, eighty-five feet in thickness, varying from light yellow to brownish red.

33. Dover Limestone. A limestone about four feet in thickness and of grayish color.

34. Somewhere from forty to seventy feet of shales, with occasional thin limestones with *Myalina perattenuata*.

35. Ten to twelve inches of very fossiliferous limestone in thin layers. Numbers 32 to 35 are as exposed on Mission creek and its tributaries near Dover. Number 35 is shown in ravines southwest of Dover, in the high region east and south of Mission creek.

Fenestella sp.
Productus nebraskensis Owen.

Aviculopecten maccoyi Meek and Hayden.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
Edmondia sp.
Limopteria marian (White) Beede.
Myalina perattenuata Meek and Hayden.
Myalina swallowi McChesney.
Pseudomonotis hawni Meek and Hayden.
Pseudomonotis cf. *kansasensis* Beede.
Schizodus sp.
Schizodus sp.
Gastropod cast.
Loxonema sp.
Pleurotomaria perhumerosa Meek.

36. Owing to lack of detailed study of the rocks from the last described to the Cottonwood limestone, it will be necessary to combine the less important strata into groups and mention only the more important. It is a matter of regret that the rocks of this part of the Kansas river section cannot be referred with certainty to the corresponding rocks of the Neosho river and Cottonwood river sections, which have been studied by various geologists. As near as I am able to judge, No. 13 of Bennett's Buffalo Mound section[11] corresponds to the Americus limestone near Emporia.[12] All the rocks between No. 35 and No. 13 of Bennett's Buffalo Mound section are put under No. 36. They consist of an alternation of thin limestones and shales. These shales form a part, at least, of the "Olpe" shales of Dr. Geo. I. Adams (by permission, from his MSS.)

37. No. 13 of Bennett's Buffalo Mound section. Probably is the equivalent of the Americus limestone before mentioned.

38. Elmdale Formation. Prosser and Beede, MSS. Shales with occasional thin limestones, quite fossiliferous in the lower portion. This is probably the same horizon as No. 2 and No. 3, except the limestone at the top, of Prosser's Manhattan section.[13] It is also, in all probability, the same horizon as No. 8 of my section on the South Fork of the Black Vermillion river.[14]

11. Ibid., p. 120.
12. Ibid., p. 80. See, also, Smith, Bull. Geol. Lyon Co. (Kans.), Emporia, 1901.
13. Bull. Geol. Soc. Amer., VI, p. 33.
14. Kans. Univ. Quart., IX, p. 193, 1901. (For July, 1900.)

However, the fossils from the latter place are given in a separate list. The thickness of these shales on the Kansas river and Mill creek are from 111 to 118 feet. Grouping the Mill creek and the Manhattan equivalents, we have the fossils of this horizon as follows:

Fusulina secalica (Say).
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
Chætetes? sp.
Crinoid stems and plates.
Archæocidaris sp.
Archæocidaris sp.
Dichotrypa subramosa Rogers, MSS.
Fistulipora nodulifera Meek.
Rhombopora lepidodendroides Meek.
Septopora biserialis (Swallow) Foerste.
Ambocœlia planoconvexa (Shumard) Hall and Clarke.
Chonetes glaber Geinitz.
Chonetes granulifer Owen.
Crania modesta White?
Derbya crassa (Meek and Hayden) Waagen.
Dielasma bovidens (Morton) White.
Enteletes hemiplicata (Hall) Hall and Clarke.
Hustedia mormoni (Marcou) Hall and Clarke.
Lingula umbonata Cox.
Meekella striaticostata (Cox) White and St. John.
Orbiculoidea manhattanensis (Meek and Hayden) Hall and Clarke.
Productus cora d' Orbigny.
Productus longispinus Sowerby.
Productus nebraskensis Owen.
Productus semireticulatus (Martin) d' Orbigny.
Productus symmetricus McChesney.
Pugnax utah (Marcou) Hall and Clarke.
Rhipidomella pecosi (Marcou) Hall and Clarke.
Seminula argentia (Shepard) Hall and Clarke.
Spirifer cameratus Morton.
Spiriferina cristata (Schlotheim) Dawson.
Allorisma subcuneatum Meek and Hayden.
Aviculopecten occidentalis (Swallow) Meek and Hayden.
Nuculana bellistriata attenuata Meek var.

Dawsonella meeki Brady? (Prosser's identification.)
Griffithides sp.

From about the same horizon on the South Fork of the Black Vermillion:

Fusulina secalica (Say).
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
Dichotrypa subramosa Rogers, MSS.
Fenestella limbata Foerste.
Fistulipora nodulifera Meek.
Septopora sp.
Thamniscus octonarius Ulrich.
Crinoid stems.
Archæocidaris sp.
Archæocidaris sp.
Ambocœlia planoconvexa (Shumard) Hall and Clarke.
Chonetes granulifer Owen.
Derbya crassa (Meek and Hayden) Waagen.
Hustedia mormoni (Marcou) Hall and Clarke.
Meekella striaticostata (Cox) White and St. John.
Productus cora d' Orbigny.
Productus longispinus Sowerby.
Productus nebraskensis Owen.
Productus semireticulatus (Martin) d' Orbigny.
Pugnax utah (Marcou) Hall and Clarke.
Rhipidomella pecosi (Marcou) Hall and Clarke.
Spirifer cameratus Morton.
Allorisma subcuneata Meek and Hayden.
Aviculopecten occidentalis (Shumard) Meek and Hayden.
Chænomya sp.
Pleurophorus whitei Beede.
? Sedgwickia altirostrata Meek and Hayden.
Euomphalus subrugosus (Meek and Worthen) Meek.
Griffithides scitula (Meek and Hayden) Vogdes.

39. Neva Limestone. Prosser and Beede, MSS. This is the "dry bone" limestone of Swallow.[15] It is a gray limestone six or eight feet in thickness, in two layers, separated by a layer of shale. It weathers very rough, from which fact Swallow called it the "dry bone" limestone.

15. See discussion in Bull. Geol. Soc. Amer., VI, p. 33 and p. 36.

40. ESKRIDGE SHALES. Prosser, MSS. About thirty feet of shales between the above and the base of the Cottonwood limestone.

41. COTTONWOOD LIMESTONE. Six feet of light buff-gray limestone, in two layers, the upper usually somewhat cherty, and filled with a small form of *Fusulina secalica* (Say). An excellent dimension stone, of wide distribution. Fossils rare.

Fusulina secalica (Say).
Lophophyllum profundum (Milne-Edwards and Haime) Foerste.
Archæocidaris sp.
Cystodictia inequimarginata Rogers.
Fenestella limbata Foerste.
Fenestella remota Foerste.
Fistulipora nodulifera Meek.
Pinnatopora sp.
Rhabdomeson americanus Rogers.
Rhombopora lepidodendroides Meek.
Septopora biserialis (Swallow) Foerste.
Streblotrypa prisca Gabb and Horn.
Chonetes granulifer Owen.
Pinna sp.
Griffithides scitula (Meek and Hayden) Vogdes.

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JUNE 14, 1902.